

## CALIBRATIONS GENERAL SECTION 10

**10.1 SCOPE.** To establish procedures to be followed for calibration of scales, material proportioning plants, bituminous distributors, and field testing equipment.

*NOTE: The values stated in either inch-pound units or SI units are to be regarded separately as the standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other.*

### **10.2 APPARATUS.**

- (a) Rule with suitable graduations to accurately measure the material to be inspected.
- (b) Stop watch with at least 0.5 second graduations.
- (c) Two sets of standard weights, one milligram to 100 grams, and one gram to 2000 grams.
- (d) Standard 50 pound [20 kg] weights as required in the specifications.

### **10.3 PROCEDURE.**

**10.3.1 General.** Calibration of truck scales, material proportioning plants, and bituminous distributors shall be performed when requested by the Division of Construction. Ready-mix concrete plants, inspected by this Division, should be calibrated at approximately six-month intervals when they are producing steadily for Department projects. Field testing equipment used by this division shall be calibrated at least once a year. If calibration forms are not required or provided, all original calibration data and calculations shall be recorded in diaries.

**10.3.2 Truck Scales.** Calibration of truck scales shall be performed in accordance with Sec 400.8.10 of the Construction Manual.

**10.3.2.1 Reports.** A copy of the calibration results including manufacturer's name, serial number, and any other pertinent data shall be furnished to the Resident Engineer involved. The data should be accompanied by a letter of transmittal indicating that the scales have been found to comply with Specification requirements.

**10.3.3 Bituminous Mixing Plants.** General plant checkout of equipment shall be performed in accordance with Sec 400.8 of the Construction Manual.

**10.3.3.1** Calibration of weighing equipment for batch plants shall be performed in accordance with Sec 400.9 of the Construction Manual.

**10.3.3.2** Calibration of proportioning equipment for continuous pugmill mixing plants shall be performed in accordance with Sec 400.10 of the Construction Manual.

**10.3.3.3** Calibration of proportioning equipment for drum mix plants shall be in accordance with Sec 400.11 of the Construction Manual.

**10.3.3.4 Reports.** A copy of the calibration results including manufacturer's name, serial number, and any other pertinent data shall be furnished to the Resident Engineer involved. The data shall be accompanied by a letter of transmittal indicating that the plant has been found to comply with specification requirements.

**10.3.4 Portland Cement Concrete Proportioning Plants.** Scales, water measuring devices, and admixture dispensers shall be calibrated in accordance with Sec 501.7 of the Construction Manual. Volumetric proportioning units for mixing Portland Cement Concrete shall be calibrated in accordance with Sec 501.15 of the Construction Manual.

**10.3.4.1** Truck mixers used for mixing of Portland Cement Concrete shall be inspected in accordance with Sec 501.7.5 of the Construction Manual.

**10.3.4.2** Central mixers used for mixing Portland Cement Concrete shall be inspected in accordance with Sec 501.7.6 of the Construction Manual.

**10.3.4.2.1** Mixing time for a central mix plant shall be established on the basis of uniformity tests as required by Specification Sec 501.5.4. Frequency of uniformity tests is to be as shown in Sec 501.16.8.1 of the Construction Manual. It is necessary to establish uniformity at each batch size furnished, however, a practical way of doing this is to perform the tests on the smallest and largest batch size the contractor proposes to furnish. Batch sizes between these two sizes may then be mixed at the mixing time established by the uniformity tests. The largest batch tested is never to exceed the manufacturer's rated mixing capacity. The smallest size batch tested is to be of a size that will allow uniform addition of all components, especially air-entraining agent and water, using the same sequence and discharge times as larger batches. It will be the inspector's responsibility to determine whether all of the mix components can be uniformly and continuously batched at that batch size, with that plant. Tests shall be performed according to the following procedures to determine compliance with the maximum permissible difference in results shown in Sec 501.16.8.1 of the Construction Manual. For plants having more than one mixer drum, the prescribed tests may be performed on only one drum if the drums are made by the same manufacturer, are of the same size, and are in comparable condition as to wear of blades, etc. All following section references are to the Construction Manual.

**(a) Weight per cubic foot [Mass per cubic meter] calculated to an air-free basis.** The procedure as shown in Sec 501.16.8 is to be followed on each of the two samples. The results are then to be compared and the difference between the two shown as the test result.

EXAMPLE:

(Inch-pound Units)

Weight per cubic foot, air-free,  
Sample A - 147.88 lb./cu ft  
Sample B - 147.07 lb./cu ft

$A(147.88) \text{ minus } B(147.07) = 0.8 \text{ lb./cu ft}$

(SI Units)

Mass per cubic meter, air-free,

Sample A - 2368.8 kg/m<sup>3</sup>

Sample B - 2355.8 kg/m<sup>3</sup>

$$A(2368.81) \text{ minus } B(2355.83) = 12.98 \text{ kg/m}^3$$

**(b) Air Content, percent by volume of concrete.** The percent air content is to be determined on each of the two samples using the procedure shown in Sec 501.16.4. The results are then to be compared and the difference between the two shown as the test result.

EXAMPLE:

Air Content,

Sample A - 5.2 percent

Sample B - 5.0 percent

$$A(5.2) \text{ minus } B(5.0) = 0.2 \text{ percent}$$

**(c) Slump.** The slump is to be determined on each of the two samples using the procedures shown in Sec 501.16.3. The results are then to be compared and the difference between the two shown as the test result.

EXAMPLE:

(Inch-pound Units)

Slump,

Sample A = 2-1/2 inches

Sample B = 2-1/4 inches

$$A(2-1/2) \text{ minus } B(2-1/4) = 1/4 \text{ inch}$$

(SI Units)

Slump,

Sample A = 65 mm

Sample B = 60 mm

$$A(65) \text{ minus } B(60) = 5 \text{ mm}$$

**(d) Coarse Aggregate Content,** portion by weight of each sample retained on a No. 4 [4.75 mm] sieve. The procedure as shown in Sec 501.16.8 is to be followed on each of the two samples. The results are then to be compared and the difference between the two shown as the test result.

EXAMPLE:

Coarse Aggregate Content,

Sample A - 50.0 percent

Sample B - 47.1 percent

$$A(50.0) \text{ minus } B(47.1) = 2.9 \text{ percent}$$



**(e) Unit Weight [Mass] of Air-Free Mortar**, based on average for all comparative samples tested. The procedure as shown in Sec 501.16.8 is to be followed on each of the two samples. The results of the two samples are then to be averaged. The percent difference between the two results is to be determined by dividing the difference between the two results by the average of the two results, multiplied by 100.

EXAMPLE:

(Inch-Pound Units)

Unit Weight of Air-Free Mortar,

Sample A - 137.58 lb./cu ft

Sample B - 136.06 lb./cu ft

$$\frac{A(137.58) + B(136.06)}{2} = 136.82 \text{ lb/cu ft}$$

$$\frac{A(137.58) - B(136.06)}{\text{Average } (136.82)} \times 100 = 1.1 \text{ percent}$$

(SI Units)

Unit Weight of Air-Free Mortar,

Sample A - 2203.82 kg/m<sup>3</sup>

Sample B - 2179.47 kg/m<sup>3</sup>

$$\frac{A(2203.82) + B(2179.47)}{2} = 2191.65 \text{ kg/m}^3$$

$$\frac{A(2203.82) - B(2179.47)}{\text{Average } (2191.65)} \times 100 = 1.1 \text{ percent}$$

**(f) Average Compressive Strength at 7 days.** The two compressive samples are to be prepared and tested as described in Sec 501.16.5. The results of the three specimens comprising each sample are to be averaged. The average result of all specimens is to be determined. The percent difference is then determined by dividing the difference between the average for each sample by the average for all specimens, multiplied by 100.

EXAMPLE:

(Inch-pound Units)

Sample A                      - Specimen 1 - 3240 psi  
                                         Specimen 2 - 3160 psi  
                                         Specimen 3 - 3230 psi

$$\frac{3240 + 3160 + 3230}{3} = 3210 \text{ psi}$$

Sample B                      - Specimen 4 - 2900 psi  
                                         Specimen 5 - 2980 psi  
                                         Specimen 6 - 3100 psi

$$\frac{2900 + 2980 + 3100}{3} = 2993 \text{ psi}$$

$$\frac{3240 + 3160 + 3230 + 2900 + 2980 + 3100}{6} = 3101 \text{ psi}$$

$$\frac{\text{Avg. A}(3210) - \text{Avg. B}(2993)}{\text{Avg.all Specimens (3102)}} \times 100 = 7.0 \text{ percent}$$

(SI Units)

Sample A                      - Specimen 1 - 22.34 MPa  
                                         Specimen 2 - 21.78 MPa  
                                         Specimen 3 - 22.27 MPa

$$\frac{22.34 + 21.78 + 22.27}{3} = 22.13 \text{ Mpa}$$

Sample B                      - Specimen 4 - 19.99 MPa  
                                         Specimen 5 - 20.55 MPa  
                                         Specimen 6 - 21.37 MPa

$$\frac{19.99 + 20.55 + 21.37}{3} = 20.64 \text{ MPa}$$

$$\frac{22.34 + 21.78 + 22.27 + 19.99 + 20.55 + 21.37}{6} = 21.83 \text{ MPa}$$

$$\frac{\text{Average A}(22.13) - \text{Average B (20.64)}}{\text{Average all Specimens (20.64)}} \times 100 = 7.0 \text{ percent}$$

**10.3.4.3 Report.** A copy of the calibration results, including uniformity test results for mixing time reduction, serial numbers, plant manufacturer's name, and any other pertinent data shall be furnished to the Resident Engineers involved. The data should be accompanied by a letter of transmittal indicating that the plant has been found to comply with Specification requirements and the approved mixing time. A copy of the report and results of the uniformity tests including calculations will be kept on file at the District Materials Office.

**10.3.5 Portland Cement Treated Base proportioning plants.** The procedure to be used for the calibration of portland cement treated base proportioning plants is shown in Sec 308.13.4 inclusive of the Construction Manual.

**10.3.5.1 Reports.** A copy of the calibration results including plant manufacturer's name, serial numbers, and any other pertinent data shall be furnished to the Resident Engineer. The data should be accompanied by a letter of transmittal indicating that the plant has been found to comply with Specification requirements.

**10.3.6 Bituminous distributors.** The calibration of all distributors will be performed by District Materials personnel. The contractor is required to furnish all equipment, materials, and assistance necessary. A calibration is required before a distributor is used for Department work. Further calibrations are not required unless the District has reason to believe that the distributor has been altered or damaged in such a manner as to make the original calibration invalid. The District participates in the calibration of distributor tanks and assigns a permanent plate to be securely attached to the distributor indicating that it has been calibrated and the results are on file in the District office. Calibration tags are available from Construction and Materials.

**10.3.6.1 Method for Calibration of a Distributor Tank.**

- (a) The distributor is emptied completely.
- (b) An accurate flow meter certified by a reputable agency or a container calibrated to measure exactly a multiple of five gallons [20 L] is obtained.
- (c) The distributor is reasonably leveled both longitudinally and transversely.
- (d) The tank is filled with liquid in increments of from 5 to 25 gallons [20 to 100 L] depending on the size of the distributor and the available equipment.
- (e) After each increment of liquid is added, the liquid in the tank must be allowed to settle to a quiet surface. Then a gauge stick held vertically against the side of the manhole, using the top of the rim or other readily identifiable portion of the distributor as a reference, is carefully lowered, centered and plumbed to just touch the surface of the liquid. The stick is then marked at reference line, removed, carefully measured to the nearest 1/16 inch [2 mm] , and recorded with the corresponding gallonage. Another acceptable method to determine the depth is to lower the stick until it touches the bottom of the distributor tank. The stick is then removed and carefully measured to the nearest 1/16 inch [2 mm] and recorded with the corresponding gallonage. Other methods may be used at the Districts' discretion providing acceptable results are obtained.

**10.3.6.2 Reports.** A complete copy of the calibration results on Form M-45 shall be furnished the contractor. The contractor should make a permanent gauge stick (preferably from aluminum 1/8 x 1 3/4 inch.[3.175 x 44.45 mm] x length required) from the measurements with markings and the corresponding volumes obtained from the calibration data. A tag number shall be assigned by the district. The gauge stick shall be checked before giving the tag to the contractor. The tag number shall be stamped on the gauge stick and recorded on Form M-45 (page 7). A completed copy of Form M-45 should be maintained with the distributor.

**10.3.6.3** New calibrations should be performed in metrics and the gauge stick marked the same way. It is acceptable to also convert the calibration to English and scribe the back of the same gauge stick with those results. The same stick is to be clearly identified as "English" or "metric" on the respective sides.

**10.3.7 Field testing equipment.** The calibration of field testing equipment used by this Division is a District responsibility and shall be performed at least once a year. Certified test weights, one milligram to 100 grams and one gram to 2000 grams shall be maintained in the District and used for calibration purposes only. These weights shall be submitted to the Laboratory for recertification before the date of expiration on the "Certificate of Test" or at least once every two years.



**10.3.7.1 Aggregate quality control scales.** The balance or scale for field use shall be calibrated from 0 to maximum capacity to an accuracy of 0.5 percent computed to the nearest gram of the net load applied, or one gram, whichever is the greater, and shall be sensitive to a weight not greater than the minimum graduation value.

**10.3.7.2 Analytical balance.** The weights for use on an analytical balance shall be calibrated to within the tolerances shown in Table 1 AASHTO M 231.

**10.3.7.3 Air Meter.** Calibration of meters designed to determine the percent air-entrainment in Portland Cement Concrete by the pressure method shall be in accordance with Sec 501.16.4 of the Construction Manual.

**10.3.7.4 Report.** A copy of the calibration data including manufacturer's name, serial numbers or identification numbers and any other pertinent data shall be filed in the District office for a minimum of five years. A sticker, label, or tag shall be affixed to each item of test equipment that has been calibrated, showing the date of last calibration.

**10.3.8 Commercial Scales.** Scales used by the Department at supplier's or manufacturer's plants shall be calibrated or verified at the discretion of the District and reports kept on file in the District Office.

